NSCL Beam Test 98: Performance of CsI Calorimeter

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NRL

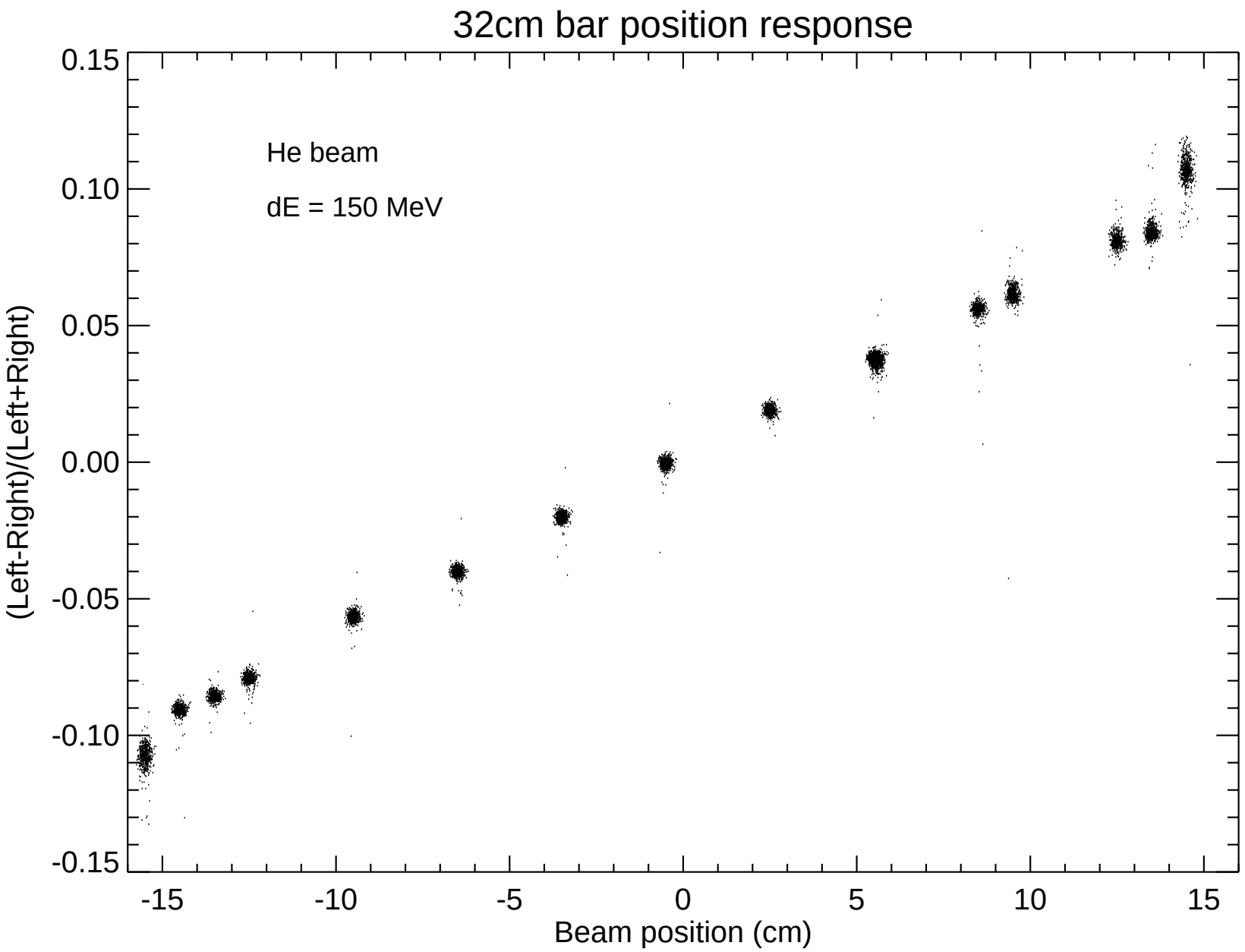
- **National Superconducting Cyclotron Laboratory, Michigan State, 27-29 Jan 1998**
- **Proton, heavy nuclei beams**

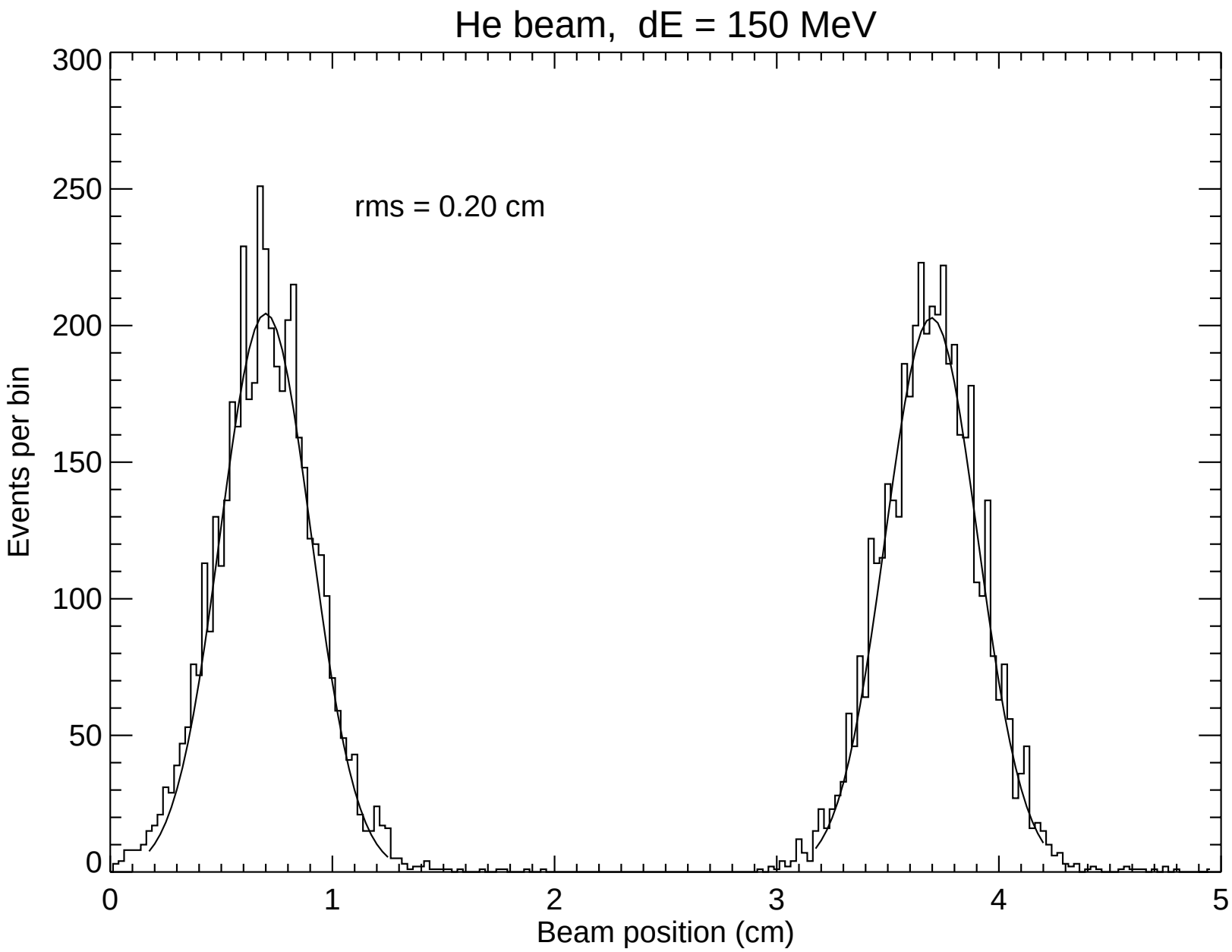
  H, H_2^+, He, and C

  Beam energy = 160.6 MeV/n

  good beam: $\Delta p/p \sim 0.1\%$ $\Delta x < 1$mm.

  He penetrates CsI bar, deposits 150 MeV ($\Delta E_{Landau} \approx 2$ MeV).
  C stops within CsI bar, deposits full beam energy, 2 GeV.
- **Test goals:**
  1. Map light collection in 32cm bar with "hairless" beam.
     Simpler measure of intrinsic energy and position resolution of CsI crystals.
  2. Study direct energy deposition in PIN photodiode.
  3. Hadronic radiation damage in CsI
     ~10 kRad over full 24cm bar.
  4. Alternative ACD detector technology.


32cm bar position response
He beam
dE = 150 MeV
(Left-Right)/(Left+Right)
Beam position (cm)
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-15
-10
-5
0
5
10
15



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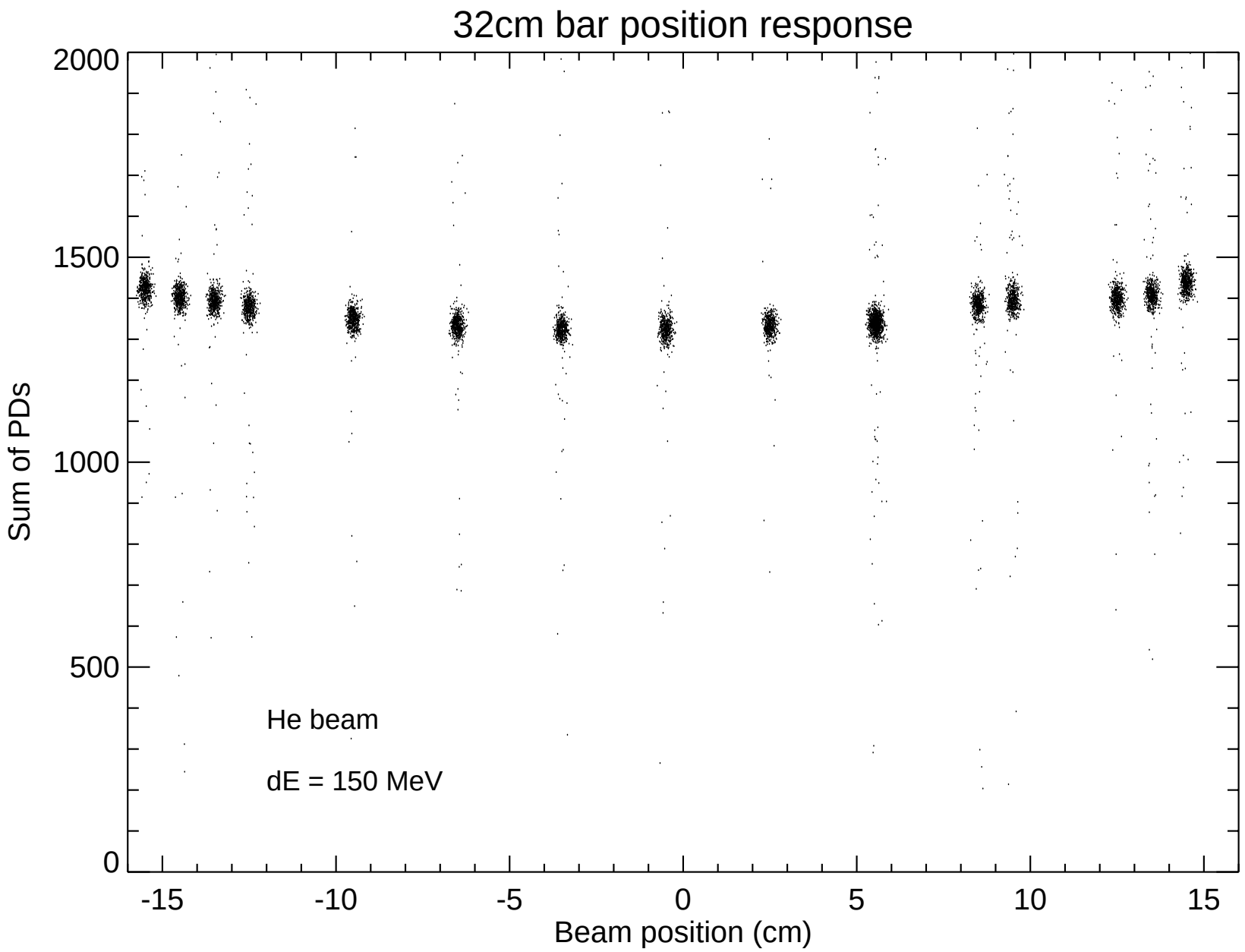
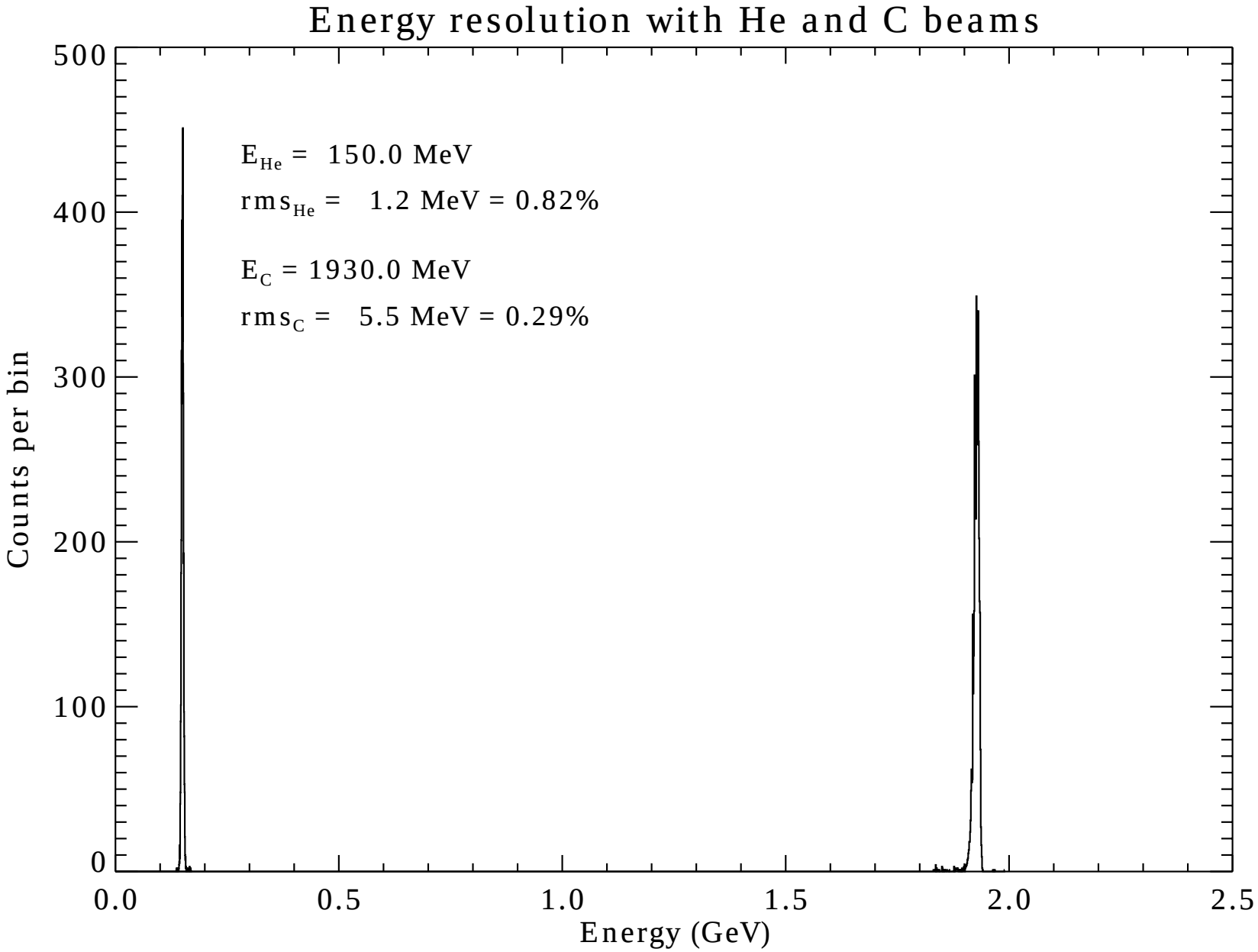

32cm bar position response
2000
1500
1000
500
0
Sum of PDs
He beam
dE = 150 MeV
-15
-10
-5
0
5
10
15
Beam position (cm)


Energy resolution with He and C beams
E_{He} = 150.0 MeV
rms_{He} = 1.2 MeV = 0.82%
E_C = 1930.0 MeV
rms_C = 5.5 MeV = 0.29%
Counts per bin
Energy (GeV)
0
100
200
300
400
500
0.0
0.5
1.0
1.5
2.0
2.5

Alternate ACD detector technology:

- **Plastic scintillator with PIN photodiode readout.**

  Photodiodes are poor match to typical plastic scintillators.

  Diode sensitivity peaks in red.

  Plastics emit in blue. Need red scintillator.

  Bicron 430

  Peak emissivity: 580 nm

  30 cm square, 1cm thick.

  Readout:

  Two 1 cm^2 PINs (S3590-03, 300μm thick) on edge.

  Two 1.8x1.8 cm^2 PINs (S3204-03, 300μm thick) on face.

  Does it work?

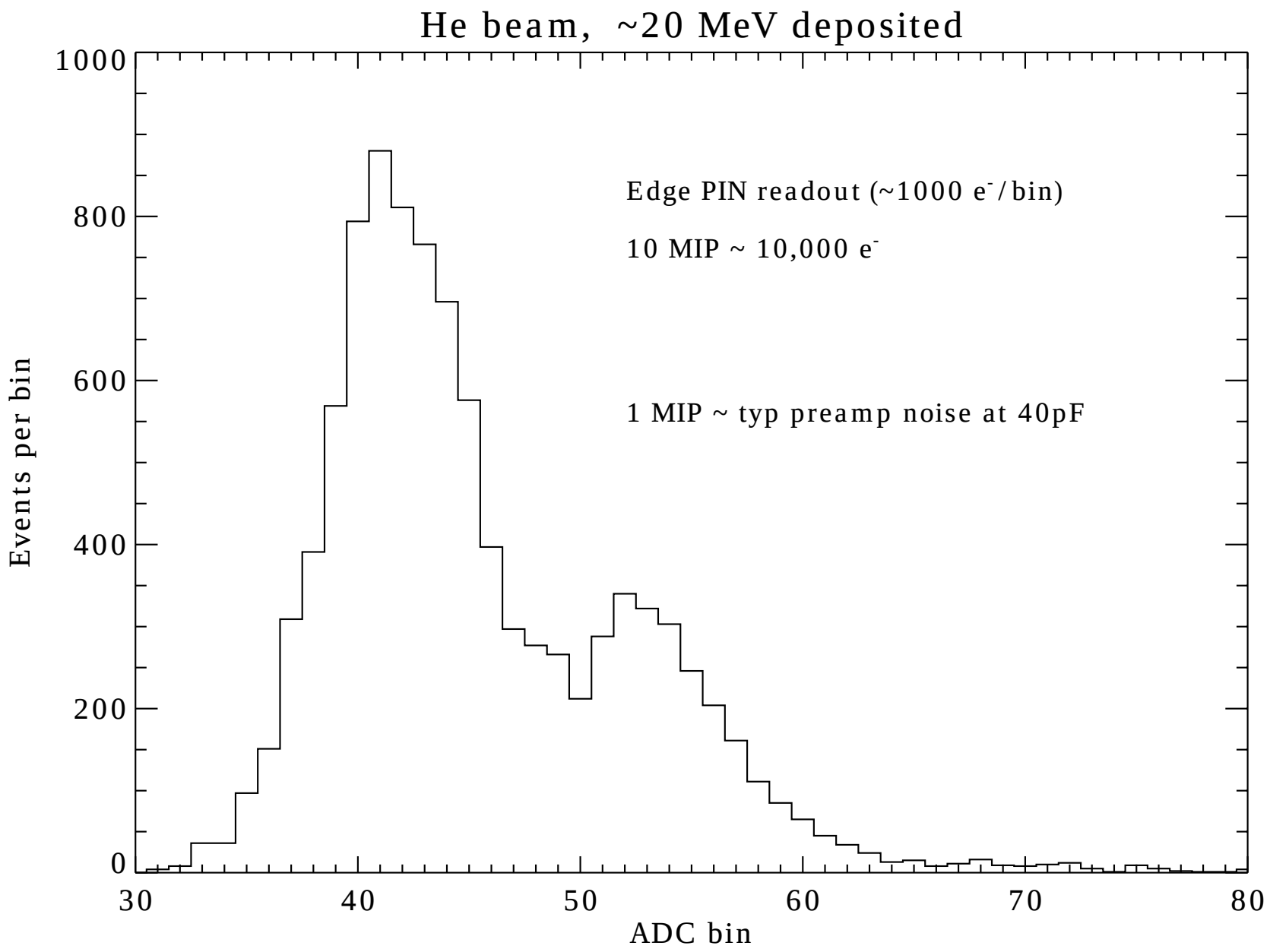
  Bicron says 15,000 to 35,000 e / MeV with PIN readout.

  Best CsI and PIN systems have ~40,000 e/MeV and ~50-100 keV noise floor.

  Since 1 MIP is >1 MeV and the ACD doesn't have to be completely hermetic,

  it's not a completely stupid idea.

  Try proton and He test beams….


He beam, ~20 MeV deposited
Edge PIN readout (~1000 e⁻/bin)
10 MIP ~ 10,000 e⁻
1 MIP ~ typ preamp noise at 40pF
Events per bin
ADC bin
0
200
400
600
800
1000
30
40
50
60
70
80